of the two lines in one spectrum is brought directly over the other in the other spectrum. The photometric parts included a Nicol capable of rotation, a right and left rotating double quartz, and a fixed Nicol. The mean value of the ratio sought, from measurements on three days, was 1·60 ± 0·01; the probable error of an observation being ± 0·032.

THE amount of electric expansion in caoutchouc has been investigated by Herren Korteweg and Julius (*Wied. Ann.* No. 4). They used tubes of white vulcanised caoutchouc made insulating in water by being kept twenty-four hours in oil; the tube was filled with water and placed in a water-bath (to form a condenser), while hydrostatic pressure was varied, and the changes of volume were measured by means of a connected tube-system. The change of volume is shown to be proportional to the square of the striking distance, and inversely proportional to the square of the thickness of tube-wall. It is the same whether the inner liquid be charged negatively or positively. The maximum was reached when the Holtz machine, left to itself, gradually slackened speed till the last spark passed. A table, giving also Quincke's data for glass, shows that both for this and for caoutchouc the volume-changes are, roughly speaking, in inverse ratio of the coefficients of elasticity, so that they must be ascribed to the same cause.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—During the Long Vacation there will be a course of lectures in the University Laboratory by Mr. Fenton, one of the Demonstrators, on Organic Chemistry. The Laboratory will be open for practical work.

During the Michaelmas Term there will be twelve courses of lectures on Chemistry and various branches of Physics, including one by Mr. Shaw on the Conservation of Energy and Theory of Unitation, and a course by Prof. Lewis on the more Common Mineral Rock-Constituents, and another on Descriptive Crystallography by the same.

Prof. Dewar's subject will be Physical Chemistry; and among other advanced lectures will be a course on the General Principles of Chemistry by Mr. Pattison-Muir.

Prof. Hughes and Mr. Tawney will divide between them the work in Geology, Mr. Tawney taking Palæontology in the Michaelmas Term.

Lectures on Botany will be given by Messrs. J. W. Hicks, Vines, Saunders, and Hillhouse. Dr. Vines' lectures in the Michaelmas Term will be on the Physiology of Plants, with practical work, at Christ's College.

Prof. Newton and the Demonstrator of Comparative Anatomy, Dr. Michael Foster, and his corps of lecturers, Prof. Humphry, Mr. Creighton, and Mr. Balfour, will give their usual series of lectures and demonstrations during the Michaelmas Term. Mr. Lea will give advanced lectures on Digestion and Chemical Physiology, and Mr. Langley will lecture on the Histology and Physiology of Muscle, Nerve and the Nervous System.

Dr. Bradbury will lecture on Pathological Anatomy, Prof. Latham on General Therapeutics, Prof. Paget on Clinical Medicine, and Mr. Carver on Clinical Surgery.

The Natural Sciences Tripos, Part I., under the Old Regulations, has just been completed, and the pass-list contains the names of thirty-three men, and three are excused the General Examination. The second part of this examination takes place in December.

The first part of the examination under the New Regulations, by which men can enter for the examination in their second year if they prefer, has just resulted in the publication of a list with five names, in alphabetical order, in the first division, viz. Messrs. Daniels (Trinity), Duncan (Caius), Earl (Christ's), Sherrington (Caius), and Wilberforce (Trinity).

The special examinations in Natural Science for the ordinary B.A. degree have yielded seven men in the first class in Chemistry, and eighteen in the second class. In Geology there was but one man in the first and one in the second class; in Botany, one in the first class; in Zoology, one in the second class.

At Trinity College the prizemen in the June examination in Natural Science were: Third year Hillier and Ritchie; second year, Daniels and Wilberforce; first year, Davis, Head, Ransom, Thompson. The prizemen at Christ's College are Shipley (first year), Earl (second year), and Parkyn (third year).

The Chancellor of the University (the Duke of Devonshire) has (with the concurrence of Earl Cairns, Chancellor of the University of Dublin) declared that the statutes of Cambridge do not preclude the University from using the Previous and the Tripos Examinations for the purpose of testing the proficiency of women, as sanctioned by the Senate on February 24, 1881.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 19.—"Molecular Magnetism," by Prof. D. E. Hughes, F.R.S.

1. *Influence of an Elastic Torsion upon a Magnetic or an Electric Conducting Wire.*—In my paper of March 7th on "Molecular Electro-Magnetic Induction," I showed that induced currents of electricity would be induced in an iron wire placed on the axis of a coil through which intermittent currents were passing, and that these currents were produced only when the wire was under the influence of a torsion not passing its limit of elasticity. It became evident that if the intermittent magnetism induced by the coil produced under torsion intermittent currents of electricity, an intermittent torsion under the influence of a constant current of electricity or a constant magnetic field would produce similar currents. This was found to be the case, and as some new phenomena presented themselves indicating clearly the molecular nature of the actions, I will describe a few of them directly relating to the subject of this paper.

The apparatus used was similar to that described in my paper of March 7th. An iron wire of 20 centims. was placed in the centre or axis of a coil of silk-covered copper wire, the exterior diameter of the coil being 5½ centims., having an interior vacant circular space of 3½ centims. The iron wire is fastened to a support at one end, the other passing through a guide, to keep it parallel but free, so that any required torsion may be given to the wire by means of a connecting arm or index. A sensitive telephone is in direct communication with the coil, or a galvanometer may be used as the currents obtained by a slow elastic torsion are slow and strong enough to be seen on a very ordinary galvanometer. I prefer, however, the telephone, because it has the intestimable advantage in these experiments of giving the exact time of the commencement or finish of an electric current. It has, however, the disadvantage of not indicating the force or direction of the current; but by means of the sonometer the true value and direction of any current is at once given. The current from a battery of two bichromate cells is sent constantly through the wire if we wish to observe the influence of the torsion of the wire upon the electric current, or a constant field of magnetic energy is given to the wire by either a separate coil or a permanent magnet. The currents obtained in the coil are induced from the change in the molecular magnetism of the wire, but we may equally obtain these currents on the wire itself without any coil by joining the telephone and rheotome direct to the wire; in the latter case it is preferable to join the wire to the primary of a small induction coil, and the telephone and rheotome upon the secondary, as then the rheotome does not interrupt the constant electric current passing through the wire. As the results are identical, I prefer to place the telephone on the coil first named, as the tones are louder and entirely free from errors of experimentation.

If we place a copper wire in the axis of the coil we produce no effect by torsion, either when under the influence of a constant magnetic field or a current passing through it, nor do we perceive any effects if we place an iron wire (2 millims. in diameter), entirely free from magnetism, and through which an electric current has never passed. I mention this negative experiment in order to prove that all the effects I shall mention are obtained only through the magnetism of the wire. If now I pass an electric current for an instant through this same wire, its molecules are instantly polarised, and I have never yet been able to restore the wire to its original condition, and the magnetisation induced by the passage of a current is far more powerful and more persistent in soft iron than tempered steel. This may be due, however, to the fact that in tempered or softened steel we find traces only of a current during the rotation by torsion of its molecules some two to three degrees of sonometer, whilst iron gives constantly a current of 70 sonometric degrees.[1]

In order to obtain these currents, we must give a slight torsion of 5° or 10° to and fro between its zero point. We then have a current during the motion of the index to the right, and a contrary current in moving the index to the left. If we use a galvanometer, we must time these movements with the oscillations of the needle; but with the telephone it gives out continuous sounds for either movement, the interruptions being only those caused by the rheotome. The direction of the current has no influence on the result; either positive to the free arm or index or negative gives equal sounds, but at the moment of reversal of the current a peculiar loud click is heard, due to the rapid change or rotation of the polarisation of its molecules, and this peculiarly loud momentary click is heard equally as well in steel as in iron, proving that it is equally polarised by the current, but that its molecular rigidity prevents rotation by torsion.

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[1] 0·8 of a Daniell battery.

If a new soft iron wire of two millims. (giving no traces of a current by torsion) has passed through it a momentary current of electricity, and then the wire observed free from the current itself, it will be found to be almost as strongly polarised as when the current was constantly on, giving by torsion a constant of fifty sonometric degrees. If, instead of passing a current through this new wire, I magnetise it strongly by a permanent magnet or coil, the longitudinal magnetism gives also 70° of current for the first torsion, but weakens rapidly, so that in a few contrary torsions only traces of a current remain, and we find also its longitudinal magnetism almost entirely dissipated. Thus there is this remarkable difference, and it is that whilst it is almost impossible to free the wire from the influence produced by a current, the longitudinal magnetism yields at once to a few torsions. We may, however, transform the ring or transversal magnetism into longitudinal magnetism by strongly magnetising the wire after a current has passed through it; this has had the effect of rotating the whole of the molecules, and they are all now symmetrical with longitudinal magnetism, then by a few torsions the wire is almost as free as a new wire; and I have found this method more efficacious than heating the wire red hot, or any other method yet tried. If I desire a constant current from longitudinal magnetism, I place at one of the extremities of the wire a large permanent magnet, whose sustaining power is five kilometres, and this keeps the wire constantly charged, resembling in some respects the effects of a constant current. The molecular magnetism or the current obtained by torsion is not so powerful from this, my strongest magnet, as that produced by the simple passage of a current, being only 50 sonometric degrees in place of 70° for that due to the passage of a current. The mere twisting of a longitudinal magnet, without regard to the rotation of its molecule having no effect, is proved by giving torsion to a steel wire strongly magnetised, when only traces of a current will be seen, perhaps one or two degrees, and a constant source of magnetism or electricity then giving no measurable effect.

If we magnetise the wire whilst the current is passing, and keep the wire constantly charged with both magnetism and electricity, the currents are at once diminished from 70° to 30°. We have here two distinct magnetic polarisations at right angles to each other, and no matter what pole of the magnet or of the current the effect is greatly diminished; the rotation of the two polarities would now require a far greater arc than previously. The importance of this experiment cannot as yet be appreciated until we learn of the great molecular change which has really occurred, and which we observe here by simply diminished effects.

If we heat the wire with a spirit flame, we find the sounds increase rapidly from 70 to 90, being the maximum slightly below red heat. I have already remarked in my previous paper this increased molecular activity due to heat, and its effects will be more clearly demonstrated when we deal with the sounds produced by intermittent currents.

2. *Influence upon the Molecular Structure of an Iron or Steel Wire by Electricity or Magnetism.*—Being desirous to modify the apparatus already described, so that it would only give indications of a current if they were of a spiral nature, the wire was kept rigidly at its zero of strain or torsion, and the coil was made so that it could revolve on an axis perpendicular to the wire; by this means, if the wire was free from strain, the centre or axis of the coil would coincide with that of the wire. Thus, with a straight copper wire, we should have a complete zero, but if this wire formed a right or left-handed helix, the coil would require moving through a given degree (on an arbitrary scale) corresponding to the diameter and closeness of the spirals in the helix; the degrees through which the coil moved were calibrated in reference to known copper helices. 50° equalled a copper wire 1 millim. diameter, formed into a helix of 1 centim. diameter, whose spiral turns were separated 1 centim. apart.

In order to obtain a perfect zero, and wide readings, with small angular movement of the coil, it is necessary that the return wire should be of copper, 2 millims. diameter, offering comparatively little resistance, and that it should be perfectly parallel with the steel or iron wire.

The rheotome is joined to a battery of two bichromate cells, and by means of a reversing switch, an intermittent current of either direction can be sent through the wire. The telephone is joined direct and alone to the coil, thus no currents react upon the coil when perpendicular to the iron, and its return wire, if not of a spiral nature.

Placing an iron wire 0·5 diameter, and passing a current through it, I found a change had taken place similar to those indicated in my paper of March 17th; but it was so difficult to keep the wire free from magnetism and slight molecular strains, that I preferred and used only in the following experiments tempered steel wire (knitting-needles I found most useful). All the effects are greatly augmented by the use of iron wire, but its molecular elasticity is so great that we cannot preserve the same zero of reading for a few seconds together, whilst with steel, 0·5 millim. diameter, the effects remained a constant until we removed the cause.

I have not as yet been able to obtain a steel wire entirely free from magnetism, and as magnetism in steel has a remarkable power over the direction of the spiral currents, I will first consider those in which I found only traces. On passing the intermittent current through these, the sounds were excessively feeble for either polarity of current, but at each reversal a single loud click could be heard, showing the instant reversal of the molecular polarity. The degree of coil indicating the twist or spirality of the current was 5° on each side of its true zero. The wire was now carefully magnetised, giving 10° on each side for different currents. The positive entering at north pole indicating 10° right-handed spiral, negative entering the same pole, a left-handed spiral, we here see in another form, a fact well known and demonstrated by De la Rive by a different method, that an electric current travels in spirals around a longitudinal magnet, and that the direction of this spiral is entirely due to which pole of an electric current enters the north or south pole. I propose soon, however, to show that under certain conditions these effects are entirely reversed.

If through this magnetised wire I pass a constant current of two bichromate cells, and at the same time an intermittent one, the spiral is increased to 15°, but the direction of the intermittent current entirely depends on that of the constant current; thus, if the positive of the constant current enters the north pole, the intermittent positive slightly increases the spiral to 17°, and the negative to 13°, both being right-handed; the two zeros of the constant battery are, however, as we might expect from the preceding experiment, on equal opposite sides of the true zero; but if we magnetise the wire whilst a constant current is passing through it, a very great molecular disturbance takes place; loud sounds are heard in the telephone, and it requires for each current a movement of the coil of 40°, or a total for the two currents of 80°. This, however, is not the only change that has taken place, as we now find that both constant currents have a right-handed spiral; the positive, under which it was magnetised, a right-handed spiral of 95°; the negative, a right-handed spiral of 15°, and the true central or zero point of the true currents indicates a permanent spiral of 55°.

This wire was magnetised in the usual way, by drawing the north pole of my magnet from the centre to one extremity, the south from the centre to the other, and this repeated until its maximum effects were obtained; in this state I found, sliding the coil at different portions, that the spiral currents were equal, and in the same direction throughout.

It now occurred to me to try the effect of using a single pole of the magnet; this was done whilst a constant current was passing through the wire, commencing at the extremity, where the positive joined, drawing the north pole through the length of the wire, from positive towards the negative; the effect was most remarkable, as the steel wire now gave out as loud tones as a piece of iron, and the degree on the coil showed 200°. The constant and intermittent currents now showed for either polarity a remarkably strong right-handed twist; the positive 200 right, and the negative 150 right-handed spirals; the molecular strain on its wire from the reaction of the electric current upon the molecular magnetism was so great, that no perfect zero would be obtained at any point, a fact already observed when a wire was under an intense strain, producing tertiary currents that superposed themselves upon the secondary. In order to compare these spiral currents with those obtained from a known helix, I found that taking a copper wire of similar diameter (0·5 millim.), and winding it closely upon the steel wire ten turns to each centimetre, having a total of 200 turns, with an exterior diameter of 1·5 millims., withdrawing the steel wire, leaving this closely wound helix free, that it gave some 190°, instead of the 200 of the steel wire alone; thus the spiral currents fully equalled a closely wound copper wire helix of 200 turns in a similar length.

If it were possible to twist a magnetised wire several turns to the right, and that its line of magnetism would coincide with that of the twist, then on passing a positive or negative current, there would be an apparent augmented or diminished spirality of the current, but both would have a right-handed twist. The result would be identical with the phenomenon described, although the cause is different.

The explanation of this phenomenon can be probably found in the fact that the constant spirality now observed is that of the electric current under which it was magnetism, for whilst magnetising it we had a powerful source of magnetism constantly reacting upon the electric current, and the constant spirality now observed is the result or remains of a violent molecular reaction at the instant of magnetisation, and the remaining evident path or spiral is that of the electric current. On testing this wire as to its longitudinal magnetic force, I found that it was less than a wire simply magnetised in the usual way; thus the effects are internal, affecting the passage of the electric current, giving, however, no external indications (except apparent weakness) of the enormous disturbance which has taken place.

3. *Molecular Sounds.*—The passage of an intermittent current through iron or other wire gives rise to sounds of a very peculiar and characteristic nature. Page in 1837 first noticed these sounds on the magnetisation of wires in a coil. De la Rive published a chapter in his "Treatise on Electricity" (1853) on this subject, and he proved that not only were sounds produced by the magnetisation of an iron wire in an inducing coil, but that sounds were equally obtained by the passage direct of the current through the wire. Gassiot, 1844, and Du Moncel, 1878–81, all have maintained the molecular character of these sounds. Reis made use of them in his, the first electric telephone invented, and these sounds have been, since the apparition of Bell's telephone, often brought forward as embodying a new form of telephone. These sounds, however, for a feeble source of electricity, are far too weak for any applied purposes, but they are most useful and interesting where we wish to observe the molecular action which takes place in a conducting wire. I have thus made use of these sounds as an independent method of research.

The apparatus was the same as in the last chapter, except no telephone was used. The intermittent electric current was connected by means of switch key, either with the coil inducing longitudinal magnetism in the wire, or could be thrown instantly through the wire itself, thus rapid observations could be made of any difference of tone or force by these two methods; a reversing key also allowed when desired a constant current of either polarity to pass through the wire under observation.

Iron of all metals that I have yet tried gave by far the loudest tones, though by means of the microphone I have been able to hear them in all metals; but iron requires no microphone to make its sounds audible, for I demonstrated at the reading of my paper, March 31st, that these sounds with two bichromate cells were clearly audible at a distance. A fine soft iron wire (No. 28) is best for loud sounds to be obtained by the direct passage of the current, but large wires (1 millim.) are required for equally loud tones from the inducing coil. By choosing any suitable wire between these sizes, we can obtain equal sounds from the longitudinal magnetism or direct current. The wire requires to be well annealed; in fact, as in all preceding experiments, the sounds are fully doubled by heating the wire to nearly red heat. There are many interesting questions that these molecular sounds can aid in resolving, but as I wish to confine the experiments to the subject of the two preceding chapters, I will relate only a few which I believe bear on the subject.

On sending an intermittent electric current through a fine soft iron wire we hear a peculiar musical ring, the cadence of which is due to that of the rheotome, but whose musical note or pitch is independent both of the diameter of the wire and the note which would be given by a mechanical vibration of the wire itself. I have not yet found what relation the note bears to the diameter of the wire; in fact, I believe it has none, as the greatest variation in different sizes and different conditions has never exceeded one octave, all these tones being in our ordinary treble clef, or near 870 single vibrations per second, whilst the mechanical vibrations due to its length, diameter, and strain vary many octaves.

I believe the pitch of the tone depends entirely upon molecular strain, and I found a remarkable difference between the molecular strain caused by longitudinal magnetism and the transversal or ring magnetism produced by the passage of a current, for if we pass the current through the coil, inducing magnetism in the wire, and then gradually increase the longitudinal mechanical strain by tightening the wire, the pitch of the note is raised some three or four tones (the note of the mechanical transversal vibrations being raised perhaps several octaves); but if we tighten the wire during the passage of an electric current through it, its pitch falls some two or three notes, and its highest notes are those obtained when the wire is quite loose. A similar but reverse action takes place as regards torsion; for if the wire is magnetised by the coil we obtain an almost complete zero of sound by simply moving the torsion index 45° on either side, and as this was the degree which gave silence in the previous experiments for the same wire, it was no doubt due to the same rotation of its polarised molecules. If we now pass a constant current through the wire whilst the intermittent one is upon the coil, we hear augmented sounds, not in pitch but loudness, and if we give torsion of 45° to one side we have silence, or nearly so, whilst the other side it gives increased tones which become silence by reversing the battery. If whilst the wire by torsion has been brought to zero, we decrease or increase the mechanical longitudinal strain, then at once the polarised molecules are rotated, giving loud sounds; and we further remark that when the wire is loosened, and we again tighten it, we gradually approach a zero, and on increasing the strain the sounds return; thus we can rotate the molecules by a compound strain of torsion and longitudinal strain.

If we wish to notice the influence of a constant current passing through the wire under the influence of the intermittent current in the coil, we find that if the wire is free from torsion that on passing the current the tones are diminished or increased according to the direction of the current; the tones then have an entirely distinctive character, for whilst preserving the same musical pitch as before, the tones are peculiar, metallic, and clear, similar to when a glass is struck, whilst the tones due to longitudinal magnetism are dull and wanting in metallic timbre. If we now turn the index of torsion upon one side, we have a zero of sound with or without the current; but the opposite direction gives increased tones whilst current is passing through the wire, but zero when not. Here again a peculiarity of timbre can be noticed, as although we have loud tones due only to the action of the current through the wire, the timbre is no longer metallic, but similar to that previously given out by the influence of the coil; evidently then the metallic ring could only be due to the angular polarisation of the molecules, and when these were rotated by torsion the tones were equally changed in its action upon the wire.

I have already shown that a permanent magnet brought near the wire could rotate its polarisation, and it equally can produce sound or silence in these molecular sounds (during that the wire is at its zero of torsion, and a constant current sent through the wire as in the last experiment). We find that either pole of the natural magnet has equal effect in slightly diminishing the sound by an equal but opposite rotation from the line of its maximum effects; but if the wire is brought nearly to zero by torsion, then on approaching one pole of the natural magnet we produce a complete silence, but the opposite pole at once rotates the molecule to its maximum loudness, and on taking away the magnet we have comparative silence as before.

Heating the wire to nearly red heat by a spirit lamp increases the tones of longitudinal magnetism induced by the coil some 25 per cent., but it has a much more marked increase on the tones produced by the direct passage of the current where they have more than 100 per cent. increase; and if we pass the intermittent current through the coil and constant through the wire, we find no direct rotation of the molecules by heat, although an apparent rotation takes place if we by the required torsion first place the wire at its zero. Then on the application of heat faint sounds are heard, which become again almost silent on cooling; this is simply due to the diminution by heat of the effect of the elastic torsion.

Tempered steel gave exceedingly faint tones, requiring the use of the microphone; but on magnetising with a constant current, inducing spiral magnetism, the sounds became audible, some 15° sonometer against 175° for iron; thus the molecular rigidity of steel as observed by previous methods was fully verified.

I have, I believe, demonstrated by actual experiments which are easy to repeat, that—

1. An electric current polarises its conductor, and that its molecular magnetism can be reconverted into an electric current by simple torsion of its wire.
2. That it is by the rotation of its molecular polarity alone that an electric current is generated by torsion.
3. That the path of an electric current through an iron or steel wire is that of a spiral.
4. That the direction of this spiral depends on the polarity of the current, or that of its magnetism.
5. That a natural magnet can be produced, having its molecular arrangement of a spiral form, and consequently reversed electric currents would both have a similar spiral in passing through it.
6. That we can rotate the polarised molecules by torsion or a compound strain of longitudinal and transversal.
7. That the rotation or movements of the molecules give out clear audible sounds.
8. That these sounds can be increased or decreased to zero by means that alone have produced rotation.
9. That by three independent methods the same effects are produced, and that they are not due to a simple change or weakening of polarity, as when rotation has been incomplete a mere mechanical vibration has at once restored the maximum effect.
10 That heat, magnetism, constant electric currents, mechanical strains and vibrations have all some effect on the result.

Linnean Society, June 2.—Sir John Lubbock, Bart., F.R.S., in the chair.—Mr. R. Romanis of Rangoon was elected a Fellow of the Society.—Dr. G. Hoggan exhibited and made remarks on preparations of the lymphatics of vascular walls.—Mr. Elwes exhibited samples of quinine made by a new process by Mr. Gammie of Sikkim.—Mr. Thos. Christy drew attention to living rubber plants from West Africa, viz., *Urostigma Vogelli* and *Tabernæmontanum crassa*, and he showed products of *Pistacia terebinthus*, viz., the nuts, the resin, and the so-called butter, separated from the resin, and used for sweetmeats in the East, also Chian turpentine from the same tree.—Sir J. Lubbock afterwards read a paper on the habits of ants, for abstract of which see p. 142.—Mr. S. O. Ridley read a paper on the genus *Plocamia* of Schmidt and some other Echinonematous sponges, with reference to the genus mentioned, for which he accepted Prof. Duncan's name of *Dirrhopalum*. He enumerated three species already described, but assigned to other genera, which must be added to it; the distribution is thus extended from the tropical Atlantic to the British, Portuguese and Ceylon Seas. He described a New Zealand species which proves to be new to science and appears to decide a point which has been disputed, viz., the existence of ceratinous material in the skeleton. Geological facts were brought forward showing the existence of the genus in the Eocene, Upper Chalk, and Greensand formations. A new genus of the same order was described, based on a species of Lamarck and two other species; it is closely allied to *Dictyocylindrus*; its distribution extends from Arabia to Australia.—Prof. Duncan also read a communication on two new species of sponges of the genus *Dirrhopalum* from the Atlantic sea-bed.—The ninth part of the Rev. Boog Watson's mollusca of the *Challenger* Expedition, family Pleurotomidæ, was read by the Secretary.

June 16.—Sir John Lubbock, Bart., president, in the chair.—Mr. Alex. Somerville, Capt. J. T. Wright, and Mr. John Forrest, the Australian explorer, were elected Fellows of the Society.—Mr. W. Hood Fitch exhibited a set of folio drawings of new orchids, species of *Odontoglossum*.—The Rev. W. Higgins showed a Holothurian (*Psolus squamatus*) got between the Falklands and Patagonia, originally figured by Otho Fred. Müller in his "Zoologia Danica," and now recorded of wide distribution.—A letter was read from Mr. W. Ferguson of Colombo, mentioning his having found *Wolffia arrhiza*, Wimm., in abundance, and discovery of *Adiantum Æthiopicum*, L., in the Kandyan country, both plants being new to Ceylon.—Mr. J. G. Baker exhibited a specimen of the inflorescence of *Aloe Paryii*, which had flowered for the first time in this country, although the drug obtained from the plant had been known for 2000 years.—Surgeon-Major Aitchison then read a communication on the flora of the Kuram Valley, Afghanistan (Part II.); he showed by a map the peculiarities of the vegetation of the district, and in illustration of his paper referred to a series of dried specimens of the plants and the products in use by the natives, and otherwise characteristically interesting.—The next paper read was on Central African plants collected by Major Serpa Pinto, by Prof. Count Ficalho and W. P. Hiern. The specimens herein discussed were collected by Major Serpa Pinto in the month of August, 1878, along the upper course of the River Ninda, an affluent of the Zambesi, on the west side of the high plateau. As regards the climate of this locality the temperature is described as variable, the weather as very dry during seven or eight months of the year, and very wet during two or three months. The nature of the soil is metamorphic argillaceous schist; the latitude is 14° 46′ S., the longitude 20° 56′ E., and the elevation 1143 metres above the ocean. The rest of the botanical collections made by Major Serpa Pinto at different points of the journey, which were much more considerable, were lost. The present little collection consists of seventy-two numbers, comprising sixty-five species in thirty-nine genera; twelve of these species are new or not previously described and published, and at least one new genus appears amongst them. Some of the specimens are too imperfect for final determination, and several of the grasses and sedges can only be generally referred to their approximate position, and not specifically ascertained. In the case of the previously-known species, the affinities of many of the species are not only with the flora of Huilla in South Angola, but also in several instances with that of extra-tropical South Africa; only a few of the species are widely distributed in the tropics of this and other continents.—There followed a paper by Mr. Edward J. Miers, viz., revision of the Idoteidæ, a family of Sessile-eyed Crustacea; and another by Prof. Ewart on the nostrils of the Cormorant. Certain structural peculiarities in the latter were described, these apparently accounting for or being related to a certain extent with the habit of the bird of flying with its mouth open.

Physical Society, June 11.—Lord Rayleigh in the chair.—New Members: Mr. J. E. H. Gordon and Mr. J. E. Stead, E.I.C.—Prof. Fleming exhibited a new form of B.A. unit-resistance coil devised by him for experiments in the Cavendish Laboratory, with a view to obviate the leakage in the older form due to condensed moisture on the paraffin insulating the electrodes, and also to facilitate the equalisation of the temperature of the coil with the medium it is placed in. For this purpose the wire is wound bare, each layer being insulated from the rest by ebonite fenders nitched to receive the turns, and the coil is inclosed in a brass box screwed together. This box is water-tight, and may be soldered or provided with a leaden washer between the two flanged halves, which screw together. Dr. Stone said he usually insulated the B.A. coil, when plunging it in water, by putting it in a beaker of paraffin oil, which was immersed in turn in the water. Prof. Ayrton pointed out the advisability of makers aiming rather at turning out exact resistances of any definite value, rather than wasting time and increasing the cost of the coils by adjusting them to a given figure, such as 1 or 10 ohms.—Prof. W. Chandler Roberts read a paper on the hardening and tempering of steel. He pointed out that few questions connected with the metallurgy of iron or steel are attracting more attention now than the relation between a metal and the gases it comes into contact with during manufacture. The carburisation of iron has long been of great interest, as shown by the work of Clouet at the end of last century, and that of Margueritte in 1865, who showed that though the conversion of iron into steel could be effected by contact with carbon even in the diamond form, it is nevertheless true that in the ordinary process carbonic acid plays a considerable part which had been overlooked. Graham's 1867 paper on the occlusion of gases by metals gave point to Margueritte's work by showing that carbonic oxide can penetrate to the centre of a mass of iron. It is introduced, in fact, at a comparatively low temperature, while a high temperature is necessary to enable the metal to appropriate the carbon and become steel. Metallurgists are now carefully investigating the effect of occluded gases in iron and steel. Prof. Roberts considered the point recently raised as to whether the hardening and tempering of steel might not be influenced by the occlusion or expulsion of gas. He described experiments by which he proves that, as steel hardens when rapidly cooled *in vacuo*, gases could not play any part in the tempering. He also dwelt on the precautions necessary to keep the metal in the experiment free from occluded gas. He then showed that

Bergman (to whom we owe our knowledge that the difference between wrought iron and steel depends on the carbon in the latter) showed in 1781 that fixed air could give up its carbon to iron; and he concluded by showing that Réaumur, so long ago as 1722, actually employed the Torricellian vacuum in experiments on the tempering of metal, the metal being placed red-hot in a highly rarefied atmosphere. Réaumur also had a clear view of the effect a gas might have on the physical properties of a metal—a point of great interest to physicists in general. Prof. Hughes expressed the opinion that temper was not due to absorption of hydrogen, but to the combination of carbon with the iron. Mr. Stroh had found that an electrically-fused steel contact was glass hard. Prof. Guthrie exhibited a steel chain which he had beautifully blackened by dipping in fused nitre. The skin might be useful in the arts, and was perhaps analogous to that produced by Barff's process. Lord Rayleigh, M. Walenn, Mr. Lecky, Dr. Coffin, Prof. Ayrton, and others continued the discussion.—Mr. Grant then read a paper on curves of electromagnetic induction, which he had traced out by means of primary and secondary coils, sliding on frames so as to take different positions with respect to one another. The paper was illustrated by experiments and diagrams.—Prof. Reinhold then read portions of a paper by Prof. S. P. Thompson on the opacity of tourmaline crystals. The optical and electric properties of these crystals are related; and Prof. Thomson propounds an explanation of this connection based on the late Clerk-Maxwell's electro-magnetic theory of light. The full paper will be published in the *Journal* of the Society.

Meteorological Society, June 15.—Mr. G. J. Symons, F.R.S., president, in the chair.—Eleven gentlemen were elected Fellows of the Society, viz. F. Crowley, A. M. Davis, Rev. R. Drake, F. H. D. Eyre, W. M. Gibson, E. W. Mathew, J.P., D.L., J. Parnell, M.A., F.R.A.S., J. Rigby, T. G. Rylands, F.L.S., F.G.S., H. Smith, and A. H. Wood.—The following papers were read:—The use of synchronous meteorological charts for determining mean values over the ocean, by Charles Harding, F.M.S.—The climate of Fiji, by R. L. Holmes, F.M.S. This paper gives the results of meteorological observations taken at Delanasau, Bua, Vanua Levu, during the ten years 1871–80.—Note on the formation of hail, by J. A. B. Oliver.—Note on a comparison of maximum and minimum temperature and rainfall observed on Table Mountain and at the Royal Observatory, Cape Town, during January and February, 1881, by John G. Gamble, M.A., M.Inst.C.E., F.M.S.—Mr. E. J. Spitta exhibited and described a new mercurial maximum and minimum registering thermometer.

PARIS

Academy of Sciences, June 13.—M. Wurtz in the chair.—The first volume of Annals of the Rio Janeiro Observatory was presented.—The following papers were read:—On a simple law of natural circular or magnetic double refraction, by M. Cornu. The decomposition of a wave polarised rectilinearly into two waves polarised circularly in opposite directions is such that the mean of the velocities of propagation of the resultant waves is equal to the velocity of the single wave which exists where the causes of decomposition do not act.—On dialdanic alcohol, by M. Wurtz.—On reproduction, by aqueous method, of orthose felspar, by MM. Friedel and Sarasin. The felspar was formed at a high temperature in the heart of a mother-water rich in alkaline silicate. The crystals were very small.—Summary account of experiments made at Pouilly-le-Fort, near Melun, on *charbon* vaccination, by M. Pasteur, with MM. Chamberland and Roux. We now possess vaccine matter of *charbon*, capable of preserving from the fatal disease, but not itself fatal, capable of cultivation at will, transportable anywhere without alteration, and prepared by a method which may probably be generalised. M. Milne-Edwards noted the analogy of some of M. Pasteur's facts to the phenomenon of alternating generations, asking whether, by changing the biological conditions, one or other term of such alternation might not be had at will.—Observations on M. Pasteur's paper, by M. Bouley. He calls attention to the successful vaccination, by MM. Arloing, Cornevin, and Thomas, against *symptomatic charbon* (which is distinct from *bacteridian charbon*). They do not use attenuated virus (like M. Pasteur), but natural virus, attenuating the effects by bringing it directly into the blood.—Reply to observations by M. de Lesseps at the last *séance*, by M. Cosson. This relates to the Tunisian Chotts.—On a system of differential equations, by M. Briordier.—On the means of saving water in double locks and acceleration of the service, by M. de Caligny.—M. Milne-Edwards presented a *brochure* on some macruran Crustaceans from great depths in the Caribbean Sea, calling attention, *inter alia*, to a large Crustacean, *Phoberus cæcus*, quite blind, which is a transitional form between groups hitherto thought very different.—M. Fouqué was elected Member in Mineralogy in room of the late M. Delesse.—On linear differential equations with periodical coefficients, by M. Floquet.—On the treatment of vines with sulphide of carbon, by M. Boiteau.—On the functions of two variables arising from the inversion of integrals of two given functions, by M. Fuchs.—On certain systems of differential equations, by M. Halphen.—On the influence of temperature on radiophonic selenium receivers, by M. Mercadier. These tend more or less quickly to a stable state relatively to effects of temperature. At ordinary temperatures and even up to 100° the resistance varies inversely as the temperature. Between 5° or 6° and 35° these variations may be approximately considered proportional one to the other.—On some means and formulæ of measurement of electric elements and coefficients of utilisation with the arrangement having two galvanometers, by M. Cabanellos.—Hemeralopia and retinian torpor, two opposite forms of Daltonism, by MM. Macé and Nicati. Hemeralopia is in general Daltonism for blue. Persons having retinian torpor are as if in a poor light; other rays than the blue are badly perceived, especially the red.—Water-raising machines, by M. de Romilly. He describes a machine, consisting, in its general form, of a shallow cylinder with vertical axis, wide circular opening above, and near the circumference the orifice of a pipe which curves upwards. The cylinder (turbine) is rotated, and the water accumulates by centrifugal force at the circumference, where it leaves tangentially through the pipe. Water can thus be raised much higher than hitherto by centrifugal force (*e.g.* 150 m. with a turbine driven by hand). Two modifications are described. The same principle is applied in oiling the machine.—Cyanides of strontium, calcium, and zinc, by M. Joannis.—Industrial preparation of crystallisable formic acid, by M. Lorin.—Researches on tertiary monamines: I. action of triethylamine on monobromised propylenes, by M. Reboul.—Nervous system of Ophiurans, by M. Apostolides.—On the squamous temporal bone in the vertebrate series, by M. Lavocat.—On *Phytolacca dioica*, by M. Balland.—On the Carboniferous fauna of Rémy (Loire), and its relations with that of Ardoisière (Allier), by M. Julien.—On the dissolution of false membranes of *angina pellicularis* by local applications of papaïne, by M. Bouchut.—On an apparatus for suppressing the dangers of movable stoves, by M. Godefroy. The air for combustion is drawn from the chimney itself by a second tube; the chimney and stove may thus be hermetically closed.

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